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(54) Device for the extinguishing of fire in rooms and aerosol-forming compositions for it

(57) The device for the extinguishing of fire in rooms comprises a housing on one front side of which at least one opening is formed and in which are provided a fire alarm means, a means for the initiation of the combustion of a charge and a channel charge, which consists of an aerosol-forming compound and has a coefficient "α" of excess oxidizing agent which lies in the range between 0.8 and 1.45 and is enclosed in a non-combustible sheath. The cooling unit consists of a porous material with a mass of 0.75 to 1.75 of the charge mass, an inert substance of a chemically active substance which is capable of decomposing without the formation of toxic components. A chamber for the formation of aerosol is provided between the channel charge of the fire-extinguishing compound and the cooling unit.

The aerosol-forming compound contains an alkali metal nitrate, a combustible binding agent, a substance which is selected from the group consisting of dicyandiamide, melem, melamine, as well as a substance which is selected from the group consisting of CuO, $K_2Cr_2O_7$, $CuCr_2O_7 \times 2H_2O$, $C_6H_2O_7N_3K$, with the following ratio of the components (mass %):

combustible binding agent 2 to 2.5
dicyandiamide or melem or melamine 15 to 20
CuO or $K_2Cr_2O_7$ or $CuCr_2O_7 \times 2H_2O$ or $C_6H_2O_7N_3K$ 1 to 3
KNO_3 and/or $NaNO_3$ remainder.

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The following specifications have been taken from the documents filed by the applicant

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Specification

The present invention relates to fire-fighting technology, particularly a device for the extinguishing of fire in rooms and an aerosol-forming compound which can be used in this device.

Devices for the extinguishing of fire in rooms are known in which cooling means are used (see, for example, GB-PS 20 20 971). The cooling means bring about a breakdown of the ozone layer of the Earth and are highly toxic.

The abovementioned disadvantages are remedied in part in devices for the extinguishing of fire in which a pyrotechnical charge or a solid propellant charge is used as a fire-extinguishing compound (see GB-PS 20 28 127).

Due to a necessarily high fire-extinguishing concentration of gaseous combustion products and their high toxicity, the abovementioned devices exhibit a low level of effectiveness.

Considered the most effective are devices for the extinguishing of fire which are based on solid propellants in which, besides the gases, very small solid particles are formed during their combustion.

The gases which develop during the burning of the solid propellants ensure the conveyance of highly dispersed solid particles into the source of fire.

Considered to be the best technical solution is a device for the extinguishing of fire in rooms which comprises a housing on the front side of which an opening is formed and in which a fire alarm means, a means for the initiation of the combustion of a charge and a channel charge are provided with a fire-extinguishing compound (see patent RF 29 46 614).

In the abovementioned device, the exiting of the combustion products takes place through an outlet in the housing.

As a smoke-forming compound, one has been used which contains alkali metal nitrate and/or alkali metal perchlorate and a combustible binding agent. The smoke-forming compound can, in

addition, contain a fuel or ammonium perchlorate. As a smoke-forming compound, one has been used which consists of alkali metal nitrate and/or alkali metal perchlorate and ballistite powder (cellulose nitrate laced with low-volatile solvent).

The disadvantages of the abovementioned devices consist in the high temperature of the gaseous aerosol stream formed behind the outlet opening of the housing with a large flame zone and in unsatisfactory toxicological characteristics of the aerosol generated due to its CO-, NH_3- and HCN component.

The incomplete oxidation of the decomposition products of the combustible binding agent and of the additional fuel due to an insufficient quantity of oxygen and the re-combustion with the oxygen in the air leads to the formation of an extensive high-temperature zone.

It is the object of the present invention to produce a device for the extinguishing of fire in rooms in which an aerosol-forming compound is used which exhibits a high level of effectiveness in the extinguishing of fire and with a low temperature of slightly toxic or non-toxic fire-extinguishing aerosol, with a minimal component of CO-, NH_3- and HCN.

The object is achieved according to the invention in that, in a device for the extinguishing of fire in rooms which comprises a housing on the front side of which at least one opening is formed and in which a fire alarm means, a means for the initiation of the combustion of a charge and a channel charge are provided with a fire-extinguishing compound,
the channel charge of the fire-extinguishing compound is arranged coaxially in the housing adjacent to one front side and consists of an aerosol-forming compound which has a coefficient "α" of excess oxidation agent which lies in the range between 0.8 and 1.45 and the outer surface of the channel charge is enclosed in a non-combustible sheath,
a cooling unit made of porous material is arranged in close proximity to the front side of the housing, on which at least one opening is formed, this porous material having a mass of 0.75 to 1.25 of the charge mass, and consisting of an inert substance or of a chemically active substance which is capable of decomposing without the formation of toxic components,
a thermally protective coating is provided on the inner side surface of the housing, and

a chamber for the formation of aerosol is formed in the housing between the channel charge of the fire-extinguishing compound and the cooling unit.

As the charge of the fire-extinguishing compound, it is advantageous to use a charge which has at least two channels.

It is advantageous to provide the device with a grating which is installed between the chamber for the formation of aerosol and the cooling unit.

It is advantageous that the layer thickness of the thermally protective coating in the chamber for the formation of aerosol be greater than the thickness of the thermally protective coating of the side surface of the housing.

It is also advantageous that the cooling unit contain granules of porous material.

The object is also achieved in that the aerosol-forming compound with a component of alkali metal nitrate and a combustible binding agent additionally contains a substance which is selected from the group consisting of dicyandiamide, melem, melamine, as well as a substance which is selected from the group consisting of CuO, $K_2Cr_2O_7$, $CuCr_2O_7 \times 2H_2O$, $C_6H_2O_7N_3K$, where KNO_3 and/or $NaNO_3$ salt is used as an alkali metal nitrate with the following ratio of the components (mass %):

combustible binding agent: 2 to 2.5
dicyandiamide or melem or melamine: 15 to 20
CuO or $K_2Cr_2O_7$ or $CuCr_2O_7 \times 2H_2O$ or $C_6H_2O_7N_3K$: 1 to 3
KNO_3 and/or $NaNO_3$ remainder.

In the following, the invention is illustrated in further detail by means of a description of a concrete embodiment with reference to drawings.

Figure 1 shows a device for the extinguishing of fire in rooms (in longitudinal section) according to the invention;

Figure 2 shows a section along the line II-II of figure 1;

Figure 3 shows a channel charge (in cross-section).

The device for the extinguishing of fire in rooms contains a housing 1 (figure 1) on the front side 2 of which at least one opening 3 is formed for the release of the fire-extinguishing products. In the described embodiment, the front side 2 of the housing 1 has a perforated design. A fire alarm means 4, a means 5 for the initiation of the combustion of a charge and a channel charge 6 are provided in the housing 1. For example, as a fire alarm means 4, a detonating fuse was used, and a pyrocartridge was used as the means for the initiation of combustion.

The channel charge 6 of the fire-extinguishing compound is arranged coaxially on one side of the housing 1 and consists of an aerosol-forming compound which has a coefficient "α" of excess oxidation agent which lies in the range between 0.8 and 1.45. The outer surface of the channel charge 6 is enclosed in a non-combustible sheath 7 made, for example, of a water glass/iron oxide mixture at a ratio of 1 : 3.

The sheath 7 of the outer surface of the charge 6 inhibits the ignition of the front and side surfaces. The design of the charge with a channel/with channels and the sheath 7 of a non-combustible compound makes it possible, depending on the requirements, to adjust the temperature of the formed aerosol through the regulation of the combustion surface of the charge.

On the other side of the housing, a cooling unit 8 consisting of porous material is provided in immediate proximity to the front side 2. The mass of the material is 0.75 to 1.25 of the mass of the channel charge 6. The cooling unit 8 contains an inert substance or a chemically active substance which is capable of decomposing without the formation of toxic components.

Provided on the inner side surface of the housing 1 is a layer 9 of a thermally protective coating – of a mica-plastic material, for example; this protects the housing 6 against overheating. The thermally protective coating in the zone of the chamber 10 for the formation of aerosol is of great significance; it makes it possible to reduce the dissipation of heat, to ensure the complete combustion of the aerosol compound and to obtain a qualitatively improved aerosol compound.

A chamber 10 for the formation of aerosol is situated between the channel charge 6 of the fire-extinguishing compound and the cooling unit 8 of the housing 1. As the channel charge 6 of the fire-extinguishing compound, a charge was used which has at least one channel 11 (figure 2). A variation is shown in which the number of channels is equivalent to five (figure 3).

In general, the number of channels can vary and depends on the output of the device.

The device also contains a grating 12 which is installed such that it forms a gap between the front side 2 of the housing and the cooling unit 8. In the grating 12, a number of openings 13 is provided for the release of the products for fire-extinguishing. The thickness of the thermally protective coating 14 in the chamber 10 for the formation of aerosol is greater than that of the thermally protective coating 9 of the side surface of the housing 1.

As an inert substance, the cooling unit 8 contains granules 15 of porous material – large-grained river sand, for example.

A distributor 16 is arranged between the chamber 10 for the formation of aerosol and the cooling unit 8 which brings about a more complete filling of the cooling unit with aerosol. However, the cooling unit 8 can also be formed of a chemically active substance which does not excrete any toxic components during decomposition, for example a substance of the class of crystal hydrates which contain water in their crystal lattice. The substance is formed into porous granules with a diameter of 8 to 10 mm which are chaotically shaken, which makes it possible to increase the degree of aerosol cooling through the enlargement of the contact surface.

The crystal hydrates can be mixed with inert natural binding agents (with kaolins or clays, for example). During the mixing stage, the porous elements can be produced in the form of granules and formed in hydraulic presses into products with different profiles.

The aerosol-forming compound contains an alkali metal nitrate and a combustible binding agent as well as a substance, in addition, which is selected from the group consisting of dicyandiamide, melem, melamine, and a substance which is selected from the group consisting of CuO, $K_2Cr_2O_7$, $CuCr_2O_7 \times 2H_2O$, $C_6H_2O_7N_3K$, where KNO_3 salt and/or $NaNO_3$ salt is used as the alkali metal nitrate with the following ratio of the components (mass %):

combustible binding agent: 2 to 2.5
dicyandiamide or melem or melamine: 15 to 20
CuO or $K_2Cr_2O_7$ or $CuCr_2O_7 \times 2H_2O$ or $C_6H_2O_7N_3K$: 1 to 3
KNO_3 and/or $NaNO_3$ remainder.

As a combustible binding agent, a phenol formaldehyde resin or an epoxide resin can be used. The design of the charge of fire extinguishing substance allows an aerosol to attain a high level of fire-extinguishing effectiveness, the distinctive feature of which is the large component of solid particles of the type K_2O, Na_2O, KOH, K_2CO_3, Na_2CO_3 as well as the inert gases N_2 and CO_2. Here, the level of re-combustion of the combustion products by means of the oxygen in the air is no longer required, since the "inner" oxygen of the oxidation agent is sufficient. The CO, NH_3 and HCN component lies significantly below the values which are permitted by the European Standard. A comparative analysis of the degree of fire-extinguishing effectiveness [and of] the content of toxic components of the most closely related equivalent solution and the claimed compound is shown in table 1.

The device for the extinguishing of fire in rooms functions in the following manner.

During a fire, the fire alarm means 4 is triggered. A heat impulse of the means 5 for the initiation ignites the channel charge 6 of the fire-extinguishing compound. Through the channel 11, the combustion products reach the chamber 10 for the formation of aerosol, where the compound burns up completely, leaving no residue, which is ensured by the high coefficient of excess oxidation agent of $0.8 \leq \alpha \leq 1.45$, the presence of the thermally protective coating 9 of the housing 1 and the non-combustible sheath 7 of the charge. Via the distributor 12, the combustion products reach the cooling unit 8. The chemically active porous substance of the cooling unit is decomposed into finely dispersed particles under the action of the high temperature of the combustion products, which simultaneously increases the level of effectiveness of the compound. Moreover, the cooling unit 8 makes it possible to reduce the aerosol temperature at the outlet of the device to the required limit values.

The combination of the special constructive features of the device with the composition of the aerosol-forming substance thus makes it possible to obtain the necessary characteristic values of the fire-extinguishing aerosol which fulfill the requirements of the European Standard with respect to the component of toxic substances with a high level of effectiveness in the extinguishing of fire.

Table 1

Characteristic Values of the Degree of Effectiveness in Extinguishing Fire

(C_T, g/m^3) of the average aerosol temperature in the device (T_{avg}, °C) and the content of toxic substances of the device according to the patent RU 2046614 and the invention of the application (acetone extinguishing)

Serial no.	Formulation	Coefficient of excess oxidation agent	Ratio of the mass of the oxidation agent to the charge mass	Size of the granules of the cooling unit	C_M	T_{avg}	CO	NH_3	HCN	Notes
	Mass %			mm	g/m^3	°C	mg/m^3	mg/m^3	mg/m^3	
1	2	3	4	5	6	7	8	9	10	11
							≤3750	≤357	≤340	European standards
1	KNO_3 55.0 PhFH 5.0 DCDA 40.0	0.38	--	--	56	710	1740	330	370	Device without cooling unit
2	KNO_3 70.0 PhFH 3.0 DCDA 25.0	0.69	--	--	52	880	1480	290	310	Device without cooling unit

PhFH - phenol formaldehyde resin, DCDA - dicyandiamide no. 1.2 Patent of the Russian Federation 20466141 3-10, 14-17 Invention of the application; 11 Unworkable example; 12, 13 Examples in which the contained quantity exceeds the limit values.

1	2	3	4	5	6	7	8	9	10	11
3	KNO_3 70.0 PhFH 5.0 DCDA 25.0 CuO 2.0	1.43	1.25	10.0	67	455	1100	345	134	Device with cooling unit
4	KNO_3 74.5 PhFH 2.5 DCDA 20.0 CuO 3.0	0.98	1.0	10.0	65	405	1105	280	155	Device with cooling unit
5	KNO_3 72.0 PhFH 2.0 DCDA 25.0 CuO 1.0	0.80	1.0	7.0	66	320	1140	325	158	Device with cooling unit
6	KNO_3 78.0 PhFH 2.0 Melem 18.0 $K_2Cr_2O_7$ 2.0	1.27	0.75	8.0	70	450	925	280	160	Device with cooling unit
7	KNO_3 70.5 PhFH 1.5 Melamine 25.0 $Cu_2Cr_2O_7 \times 2H_2O$ 3.0	0.82	1.0	10.0	63	325	1130	320	155	Device with cooling unit

1	2	3	4	5	6	7	8	9	10	11
8	$NaNO_3$ 30.0 KNO_3 45.0 PhFH 2.0 DCDA 20.0 $C_6H_2O_7N_3K$ 3.0	1.12	1.2	9.0	66	380	1180	3[?]0	145	Device with cooling unit
9	$NaNO_3$ 68.5 PhFH 2.0 DCDA 20.0 $K_2Cr_2O_7$ 1.5	0.84	1.0	9.0	72	290	1850	375	358	Device with cooling unit
10	KNO_3 82.8 PhFH 2.0 DCDA 13.0 $K_2Cr_2O_7$ 2.2	1.45	1.2	8.0	80	470	1750	395	318	Device with cooling unit
11	KNO_3 38.5 NaNO3 38.0 PhFH 1.0 DCDA 20.0 CuO 2.5	1.1	--	--	--	--	--	--	--	Charge does not burn
12	KNO_3 69.0 PhFH 5.0 DCDA 25.0 CuO 1.0	0.75	1.0	10.0	90	300	2950	510	410	Device with cooling unit

1	2	3	4	5	6	7	8	9	10	11
13	KNO_3 84.5 PhFH 2.0 DCDA 10.0 CuO 3.5	1.55	1.1	9.0	92	490	2980	585	390	Device with cooling unit
14	KNO_3 76.0 PhFH 2.0 Melem 20.0 $K_2Cr_2O_7$ 2.0	1.24	0.65	8.0	72	610	920	395	220	Device with cooling unit
15	KNO_3 81.0 PhFH 2.0 DCDA 15.0 CuO 2.0	1.43	1.4	10.0	85	390	3770	420	355	Device with cooling unit
16	KNO_3 74.5 PhFH 2.5 DCDA 20.0 CuO 3.0	0.98	1.0	5.0	98	360	3820	455	320	Device with cooling unit
17	$NaNO_3$ 15.0 KNO_3 65.0 PhFH 2.0 DCDA 15.0 $C_6H_2O_7N_3K$ 3.0	1.25	0.15	12.0	62	530	910	295	210	Device with cooling unit

Patent claims

1. Device for the extinguishing of fire in rooms comprising a housing (1) on the front side (2) of which at least one opening (3) is formed and in which a fire alarm means (4), a means for the initiation of the combustion of a charge and a channel charge (6) of a fire-extinguishing compound are provided, characterized in that the channel charge (6) is arranged coaxially in the housing (1) on one front side and consists of an aerosol-forming compound which has a coefficient "α" for the excess oxidation agent which lies in the range between 0.8 and 1.45, and the outer surface of the channel charge (6) is enclosed in a non-combustible sheath (7),
in immediate proximity to the other front side (2) of the housing (1), in which at least one opening (3) is formed, a cooling unit (8) made of porous material is arranged whose mass is 0.75 to 1.25 of the mass of the charge (6) and which consists of an inert substance or of a chemically active substance which is capable of decomposing without the formation of toxic components,
a layer (9) of a thermally protective coating is provided on the inner side surface of the housing (1), and a chamber (10) for the formation of aerosol is formed in the housing (1) between the channel charge (6) of the fire-extinguishing compound and the cooling unit (8).

2. Device according to claim 1, characterized in that, as a channel charge (6) of the fire-extinguishing compound, a charge is used which has at least two channels (11).

3. Device according to claim 1 or 2, characterized in that it is provided with a grating (16) which is arranged between the chamber (10) for the formation of aerosol and the cooling unit (8).

4. Device according to one of claims 1 to 3, characterized in that the layer of the thermally protective coating (14) in the chamber (10) for the formation of aerosol is thicker than the thermally protective coating (9) on the side surface of the housing (1).

5. Device according to one of claims 1 to 4, characterized in that the cooling unit (8) contains granules (15) of porous material.

6. Aerosol-forming compound containing an alkali metal nitrate and a combustible binding agent, characterized in that it additionally contains a substance which is selected from the group consisting of dicyandiamide, melem, melamine, as well as a substance which is selected from the group consisting of CuO, $K_2Cr_2O_7$, $CuCr_2O_7 \times 2H_2O$, $C_6H_2O_7N_3K$, where KNO_3 and/or $NaNO_3$ salt is used as an alkali metal nitrate with the following ratio of the components (mass %):

combustible binding agent: 2 to 2.5
dicyandiamide or melem or melamine: 15 to 20
CuO or $K_2Cr_2O_7$ or $CuCr_2O_7 \times 2H_2O$ or $C_6H_2O_7N_3K$: γ [sic] to 3
KNO_3 and/or $NaNO_3$ remainder.

With 1 page(s) of drawings

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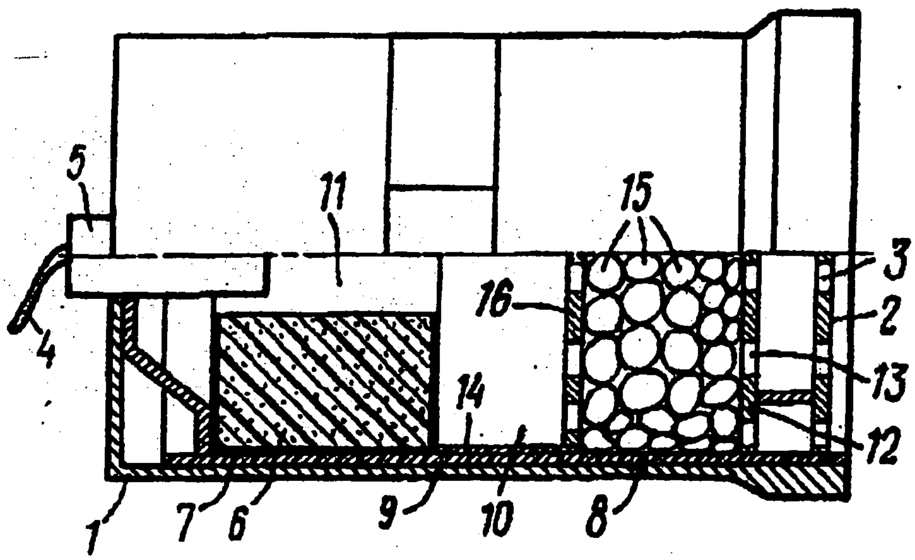

FIG. 1

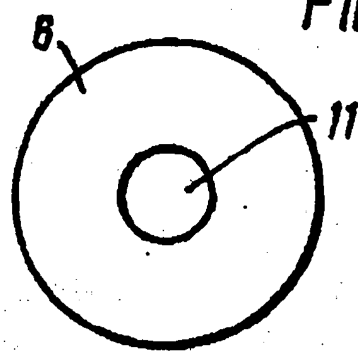

FIG. 2

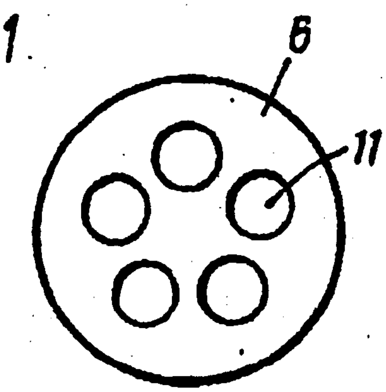

FIG. 3